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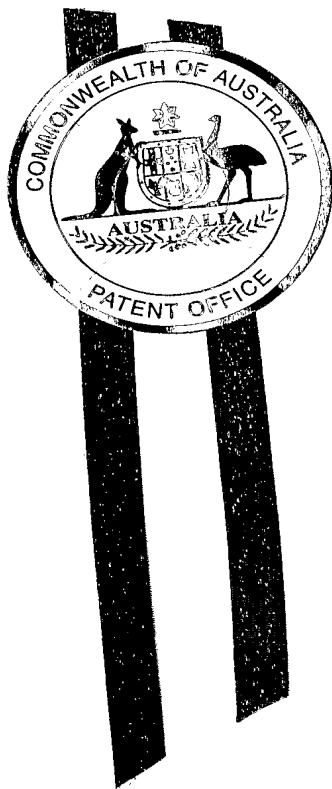


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WITNESS my hand this  
Fifth day of April 2005

A handwritten signature in dark ink, appearing to read 'J. K. + C.' with a flourish.

JANENE PEISKER  
TEAM LEADER EXAMINATION  
SUPPORT AND SALES

AUSTRALIA  
Patents Act 1990

PROVISIONAL SPECIFICATION

Applicant:

INTEC LTD

Invention Title:

PROCESS FOR THE RECOVERY OF METALS FROM LATERITE ORES

The invention is described in the following statement:

## Process for the Recovery of Metals from Laterite Ores

### FIELD OF THE INVENTION

- 5       The present invention relates to a process for the recovery of metals from laterite ores, especially nickel and/or cobalt and optionally other metals. The process employs a halide-based leach, and a purification stage, typically precipitation, for metal recovery.
- 10      Advantageously, the halide leach enables the process to be conducted at atmospheric pressure.

### BACKGROUND TO THE INVENTION

- 15      Laterite ores can have a refractory characteristic and, for this reason, smelting processes have been used to recover nickel, cobalt and other metals from laterite ores. However, the severe environmental repercussions of smelting processes have lead to the development of hydrometallurgical recovery processes for laterite ores.
- 20      Known hydrometallurgical processes for the recovery of metals such as nickel and/or cobalt from laterite ores have primarily involved pressure acid leaching, typically at high pressures and employing sulfuric acid. Sulfuric acid is employed because of its abundance, cost and well-
- 25      known chemistry.

- 30      Recently, processes have been proposed which are based on a chloride acid leach as opposed to a sulphuric acid leach. Whilst a chloride leaching medium is a powerful lixiviant, it is corrosive and requires apparatus to be chloride resistant. Chloride media have also been avoided because they have a high acid consumption and can present difficulties with the control of iron and

magnesium leaching, both metals typically present in laterites.

The company Chesbar Resources (now known as Jaguar Nickel Inc.) presented a paper at the ALTA 2002 Conference (Nickel/Cobalt-9 session) in Perth, Western Australia on May 18-20, 2003. The paper entitled "Beyond PAL: The Chesbar Option, AAL" outlined a process for the atmospheric chloride acid leaching of nickel laterite ores. The proposed Chesbar process requires the use of a pyrohydrolysis stage to regenerate from the process liquor HCl as a gas for recycle to leaching, and to regenerate magnesium oxide for use in a nickel/cobalt precipitation stage. However, HCl gas is difficult to handle, being highly corrosive. In addition, a pyrohydrolysis stage has both high capital and operating costs.

It would be advantageous if a halide based process could be provided for the recovery from laterite ores of metals such as nickel, cobalt, copper, precious metals etc, which does not require a pyrohydrolysis stage and which does not require recycle of a corrosive gas for the acid leaching stage.

#### SUMMARY OF THE INVENTION

In a first aspect the present invention provides a process for recovering a target metal from a laterite ore comprising the steps of:

- in a leaching stage, leaching the laterite ore (or a concentrate thereof) with an acidic aqueous halide solution to leach the target metal into solution, the leaching solution being generated by adding sulfuric acid to a solution comprising a metal halide;
- passing the solution from the leaching stage to a precipitation stage in which a precipitate of the target

metal is formed by adding a precipitation agent to the solution; and

- separating the solution from the target metal precipitate and returning the solution with the metal halide therein to the leaching stage.

A major advantage of a halide based leaching process is that it can operate at atmospheric pressures. However, as a further significant advantage, by choosing to add sulfuric acid to the process the pyrohydrolysis stage of the prior art can surprisingly be eliminated, as can the recycling of a hydrogen chloride gas. This represents substantial savings in capital and operating costs, well in excess of the cost of producing sulfuric acid.

In addition, where a sulfuric acid plant is employed to produce sulfuric acid for addition to the solution, such plants produce massive amounts of excess heat (ie. as a result of exothermic reactions) which can then be used to heat the process solution, representing further savings in capital and operating costs.

Typically the target metal includes nickel and/or cobalt, but may include precious metals etc, depending on the composition of the laterite.

As a further advantage a solution metal is selected so as not to interfere with leaching of the target metal or its recovery as a precipitate. Advantageously a solution metal is selected that forms a precipitate with the sulfate anion of the acid, and such that a hydrohalous acid forms as the metal sulfate precipitates. In this regard, typically the solution metal is calcium so that the precipitate is calcium sulfate. However, sodium can be present as a solution metal where the halide is derived from a sodium halide salt. In addition, magnesium chloride

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may also be used when the laterite contains high levels of magnesium (eg. to suppress Mg extraction).

Typically the halide is chloride, again because of the abundance of low cost chloride salts such as NaCl.

5 Hence, hydrochloric acid will continuously be formed in the leaching stage as the solution metal precipitates with the sulfate, without the need to form and add or recycle hydrogen chloride gas, as in the prior art. This avoids the handling difficulties and hazards associated with  
10 hydrogen chloride gas. However, other halides such as bromide or iodide can be employed, for example, where the laterite ore includes precious metals. In this regard NaBr may then also be added to the solution, as bromide complexes more strongly than chloride and hence can  
15 stabilise the precious metals in solution.

Typically the process is operated such that addition of the precipitation agent introduces the solution metal.

Also, depending on the type of laterite, the leaching stage may comprise first and second leaching stages  
20 operating in a counter-current configuration, wherein the sulfuric acid is added to the second stage. This arrangement can minimise overall consumption of sulfuric acid, as initial laterite leaching in the first leaching stage is performed by a residual acid recycle stream.

25 In this regard, the laterite ore or concentrate can be fed to the first leaching stage and contacted with a recycle of residual acid in solution from the second leaching stage to leach the ore or concentrate and produce at least partially leached laterite solids in the  
30 solution, and the solution can then be separated from the solids and passed to the precipitation stage. The separated solids can then be passed to the second leaching

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stage for contact with the added sulfuric acid to further leach the laterite solids.

When the laterite ore or concentrate includes iron, typically a proportion of iron is leached into solution in the first leaching stage, and such that a proportion of the leached iron is precipitated as ferric oxide, the ferric oxide precipitate passing with the solids to the second leaching stage.

Optionally air can be added to the first and/or second leaching stages, with or without the addition of copper as the  $\text{Cu}^+/\text{Cu}^{2+}$  oxidation couple, to maximise iron oxidation such that all iron precipitates as ferric oxide in the leaching stage.

Typically the leached solids and solution from the second leaching stage are separated in a separation stage, with the solution being recycled to the first leaching stage and the solids discarded.

Typically the return solution from the precipitation stage is first passed to the separation stage to wash the separated solids, prior to being recombined with the solution recycled to the first leaching stage. This wash helps maximise retrieval of the target metal.

Typically the precipitation stage comprises an iron removal stage and one or more subsequent target metal precipitation stage(s), to ensure minimal (if any) iron contamination of the target metal. In the iron removal stage, iron in solution can be caused to precipitate by adding to the solution a carbonate of the solution metal, and the precipitate can then be separated from the solution. When the solution metal is calcium, the carbonate is calcium carbonate, and advantageously the addition to the solution of the calcium carbonate



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increases solution pH and causes iron to precipitate as ferric oxide.

When the target metal includes a precious metal, the precious metal can be removed as a precipitate, typically  
5 by adding NaSH to the solution.

When the target metal is nickel and/or cobalt, the nickel and/or cobalt can be removed as a precipitate by adding to the solution a hydroxide of the solution metal. For example, when the solution metal is calcium, the  
10 hydroxide is calcium hydroxide (eg. slaked lime).

Typically the ore or concentrate has a residence time in the leaching stage greater than 10 hours, such that iron present in the laterite is leached and oxidised through to haematite, which is highly stable and safe to  
15 the environment when disposed of.

Typically the sulfuric acid is added to the leaching stage to achieve a pH in the range 0 to 1 and a solution Eh of -600mV. Typically the solution in the leaching stage has a temperature in the range 85 - 95°C.

20 Typically when the halide is chloride, total chloride concentration is in the range of 6 to 8 M, and when the solution metal is calcium, at least 30g/l of  $\text{CaCl}_2$  is maintained in the leaching stage.

In a second aspect the present invention provides a  
25 process for leaching a target metal from a laterite ore (or a concentrate thereof). The process comprises first and second leaching stages having an acidic aqueous halide solution for leaching the target metal into solution passing counter-currently therethrough. In the process  
30 acid is added to the second stage, and the laterite ore or concentrate is fed to the first leaching stage and contacted with a recycle of residual acid in solution from the second leaching stage to leach the ore or concentrate

and produce at least partially leached laterite solids in the solution. The solution is separated from the solids and can be passed to target metal recovery, and the solids are passed to the second leaching stage for contact with the added acid to further leach the laterite solids.

The process of the second aspect is particularly advantageous where the laterite ore or concentrate includes iron, particularly at high levels. Thus a proportion of the iron can be leached into solution in the first leaching stage and a proportion of the leached iron can be precipitated as ferric oxide, typically haematite. The ferric oxide (eg haematite) precipitate can then pass with the solids to the second leaching stage and can thereafter pass from the second leaching stage to disposal.

In a third aspect the present invention provides a process for recovering a target metal from a laterite ore comprising the steps of:

- in a leaching stage, leaching the laterite ore (or a concentrate thereof) with an acidic aqueous halide solution to leach the target metal into solution, the leaching solution being generated by adding sulfuric acid to a solution comprising a metal halide; and
- passing the solution from the leaching stage to a purification stage in which the target metal is separated from the solution and the solution with the metal halide therein is returned to the leaching stage.

The process of the second and third aspects can otherwise be as defined for the first aspect.

Advantageously the present invention extends to any metal produced by the process any one of the preceding claims.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Notwithstanding any other forms which may fall within the scope of the present invention, a preferred form of the invention will now be described, by way of example only, with reference to the accompanying drawing in which:

Figure 1 shows a flow diagram for a process for recovering metals from a laterite ore, in accordance with the present invention.

**MODES FOR CARRYING OUT THE INVENTION**

Referring to Figure 1, it will be seen that a recovery process according to the invention comprises a LEACH process coupled to a PURIFICATION (eg. precipitation) process with solution recycle.

In the LEACH process, a lateritic ore 10 (which could also be a pre-prepared laterite concentrate) is crushed and ground at 12 and is then fed to an optional two stage counter-current leaching process having a first leach stage 14 and a second leach stage 16, both of which operate at atmospheric pressure. The counter-current two stage leach benefits  $H_2SO_4$  consumption as compared to a single stage leach but is more complex. Whilst a single stage leach is preferably used for simplicity and cost, the actual configuration used depends on the lateritic feed composition. With feed variation, the degree of benefit of  $H_2SO_4$  consumption will vary and the two stage configuration may or may not be required.

An acidic aqueous calcium chloride solution is passed through leach stage 16, the solution having a pH in the range of 0-1. This pH is achieved through the addition of sulfuric acid at levels sufficient to leach into solution target metals such as nickel, cobalt and precious metals. The solution leaches the already partially leached

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laterite residual solids that are received from leach stage 14 via a thickening stage 18.

In leach stage 16 the solution has a temperature in the range of 85 to 95°C, an Eh controlled at -600mV (versus Ag/AgCl), and a total chloride concentration in the range of 6 to 8M. However, the required solution for leaching (also referred to herein as the electrolyte) depends on the mineralogy of the lateritic ore, in particular the types and quantities of acid consumers contained in the ore. For example, a minimum of 30g/l of CaCl<sub>2</sub> is maintained in the leach to suppress jarosite formation, in turn optimising iron precipitation as haematite. The solution residence time is typically greater than 10 hours, to achieve full iron oxidation, and to release target metals into solution. Optionally, air can be sparged into the solution to maximise iron oxidation, and copper can be added to further assist oxidation as described below.

The slurry of leached solids and solution is then passed from stage 16 to a filtration stage 20 where residual solids are filtered and separated, the solids being washed by a CaCl<sub>2</sub> recycle stream 22 from the PURIFICATION process (with an optional additional water wash being employed) to recover interstitial target metals. The washed solids are disposed of whereas the solution and stream 22 (and any wash water) are combined and recycled to the first leach stage 14.

The acid depleted recycle now has a higher pH (the differential may be 1 or greater) and is used for a preliminary leach of the ore 10. The acid depleted recycle typically leaches a proportion of the iron into solution, from goethite ( $\alpha$ -FeOOH) and akagenite ( $\beta$ -FeOOH) through to haematite (Fe<sub>2</sub>O<sub>3</sub>) as described below. Again the residence time can be 10 hours or greater and, aside from pH and Eh,

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the solution parameters in stage 14 are similar to stage 16 described above. The partially leached solids and solution are then passed to thickening stage 18 where a clear liquor overflow is passed to the PURIFICATION process and the solids underflow is passed to second leach stage 16.

In the PURIFICATION process the clear liquor overflow is first passed to an iron removal stage 24, where calcium carbonate is added to cause haematite ( $\text{Fe}_2\text{O}_3$ ) to form and precipitate (described below). The haematite is filtered out at separation stage 26.

Optionally, where copper has been used in the leaching process to enhance oxidation, the copper is next removed from the liquor at copper precipitation stage 28 by the addition of calcium carbonate, and is filtered out at separation stage 30. The copper residue can be reclaimed, or recycled back to the leaching process for re-use, as recycle 32.

The liquor is now passed to a precious metal recovery stage 34 where NaSH is added to precipitate out the precious metals (described below). The precious metals are filtered out at separation stage 36 and recovered by smelting etc.

Next, the liquor is passed to a nickel/cobalt recovery stage 38 where slaked lime ( $\text{Ca}(\text{OH})_2$ ) is added to precipitate out the nickel and cobalt. The nickel and cobalt are filtered out at separation stage 40 and are then recovered. Any lead (Pb) in the ore can also be recovered at this stage.

Finally, where magnesium is present in the ore the liquor can be passed to a magnesium recovery stage 42, again where slaked lime ( $\text{Ca}(\text{OH})_2$ ) is added to precipitate out the magnesium (described below). The magnesium is then

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filtered out at separation stage 44 and recovered, optionally with any other metals still present in the liquor.

The resulting purified liquor ( $\text{CaCl}_2$  recycle solution 22) is now returned to the LEACHING process.

A non-limiting example according to the present invention will now be described.

#### Example

A process, hereafter referred to as the Intec Laterite Process (ILP) was developed as a halide-based alternative for the recovery of nickel and associated by-products from lateritic deposits. Previously the development of such deposits was generally by way of pressure acid leach (PAL) or high pressure acid leaching (HPAL).

The ILP uses a chloride medium, as opposed to the conventional sulphate medium in PAL and HPAL. The main advantage of the chloride medium is the ability to operate the leach at atmospheric pressure, without reliance on pyrohydrolysis to recover  $\text{HCl}$  for leaching and  $\text{MgO}$  for liquor purification.

The ILP is based on the input of  $\text{H}_2\text{SO}_4$  for leaching and a calcium based alkali for purification, which eliminates the need for pyrohydrolysis. The ILP process is also not constrained by the types of halide salts that were used. In this respect  $\text{NaCl}$  is a more cost effective source of chloride ion, whilst  $\text{NaBr}$  can be used to enhance the complexing of precious metals ( $\text{Au}$ ,  $\text{Ag}$ ,  $\text{Pt}$ , etc).

Conditions in the ILP leach are conducive to haematite precipitation. In particular, the temperature is in the range of  $85$  to  $95^\circ\text{C}$ ,  $\text{pH}$   $0-1$ , residence time  $>10$  hours,  $\text{Eh}$  is controlled at  $\sim 600\text{mV}$  (versus  $\text{Ag}/\text{AgCl}$ ) eg.

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by air addition, and total chloride is in the range of 6 to 8M.

#### Chemistry

Reference will now be made to the two main circuits of

5 LEACH and PURIFICATION shown in Figure 1.

#### LEACH

The leach configuration and conditions depend on:

- the mineralogy of the lateritic material; and
  - the relationship between acid consumption and metal
- 10 extraction.

The countercurrent two stage leach shown in Figure 1 benefits  $H_2SO_4$  consumption as compared to a single stage leach. The actual configuration used depends on the degree

15 of this benefit as compared to the added complexity of the countercurrent arrangement.

The solution or electrolyte for leaching depends on the mineralogy of the material, in particular the types and quantities of contained acid consumers. A minimum of

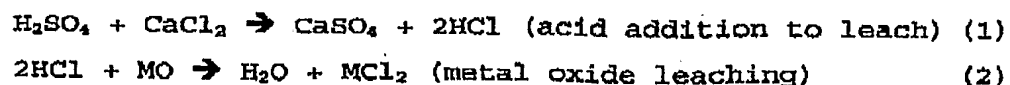
20 30g/l of  $CaCl_2$  is maintained in the leach to suppress jarosite formation in turn optimising iron precipitation as haematite.

The preferred source of chloride is NaCl due to its low cost, but when the laterite contains high levels of

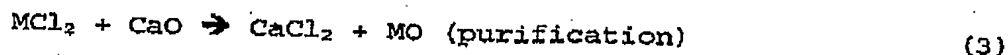
25 Mg, then  $MgCl_2$  is used to suppress Mg extraction in order to minimise  $H_2SO_4$  demand. The actual  $H_2SO_4$  demand is a compromise between its cost and the value of extracted metals.

The level of  $CaCl_2$  in the incoming leach liquor is

30 equivalent to the  $H_2SO_4$  demand according to the following mechanism:



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Thus the higher the overall metal leached the greater the background of  $\text{CaCl}_2$ , due to the increased addition of acid to the leach and alkali in purification.

- 5 The option exists to add NaBr to the background electrolyte where high levels of precious metals exist in the feed. Bromide is a stronger complex than chloride in terms of its ability to stabilise the precious metal ions in solution.

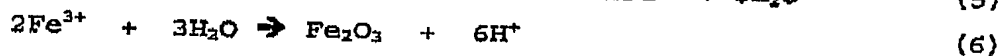
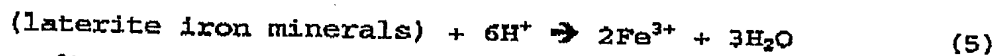
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- An important aspect of the leach is to maximise the rejection of iron as haematite ( $\text{Fe}_2\text{O}_3$ ). The formation of goethite ( $\alpha\text{-FeOOH}$ ) and akagenite ( $\beta\text{-FeOOH}$ ) in the chloride medium is well understood, but over time the  $\text{FeOOH}$  undergoes metamorphosis to haematite according to the reaction:



- Haematite is the main form of iron oxide generated and this is attributed to the high residence time at > 10 hours, the relatively high temperature at >85°C, the desiccating effect of the chloride medium and the availability of seed particles in a continuous leach.

- Another important aspect of the process is to minimize the consumption of  $\text{H}_2\text{SO}_4$  and consequently  $\text{CaCO}_3$ . This is achieved through the metamorphosis reaction (4) described above. Haematite ( $\text{Fe}_2\text{O}_3$ ) is a significantly more stable form of iron oxide than goethite or the various forms found in laterite ores. The transformation of lateritic iron minerals through goethite to haematite has no net consumption of acid as shown by the reactions below:





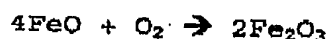
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(laterite iron minerals)  $\rightarrow$   $\text{Fe}_2\text{O}_3$ 

(7)

Acid consumption can be very significantly reduced by this route, and consequently, process economics are significantly improved.

Air is added to the leach to maximise iron precipitation by ensuring any reduced species such as  $\text{FeO}$  are oxidised to  $\text{Fe}_2\text{O}_3$  as per the reaction:



(8)

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The rate of air addition is controlled to maintain the Eh at  $\sim 600\text{mV}$  (versus  $\text{Ag}/\text{AgCl}$ ). Further there exists the possibility of adding copper into the electrolyte as the  $\text{Cu}^+/\text{Cu}^{2+}$  oxidation couple is more effective than the  $\text{Fe}^{2+}/\text{Fe}^{3+}$  couple in the uptake of oxygen.

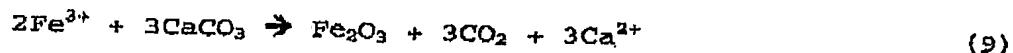
The residue generated from the leach is firstly washed with brine from the purification circuit to displace valuable metal ions from the interstitial liquor. Subsequently a countercurrent washing regime is used to minimise wash water, which ultimately must be evaporated from the liquor through the input of heat.

#### PURIFICATION

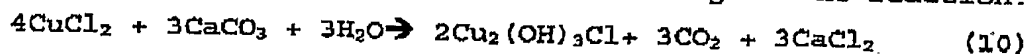
Purification in Figure 1 is based on precipitation with the calcium based alkalis of  $\text{CaCO}_3$  and  $\text{Ca}(\text{OH})_2$ . An alternative to precipitation could be solvent extraction (or ion exchange) where the various metal cations are extracted in the process, replenishing the solution with acid ( $\text{H}^+$ ). The choice of purification is a trade off between the cost of solvent extraction and its increased complexity versus the reduced acid demand and the possibly higher value of products generated.

In the alkali precipitation route iron is the first to be precipitated at pH 2 with the addition of limestone according to the reaction:

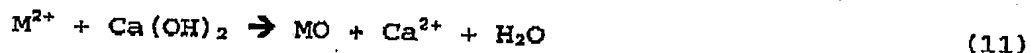
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Subsequently, copper is precipitated at pH 3 to 4 with the addition of limestone according to the reaction:

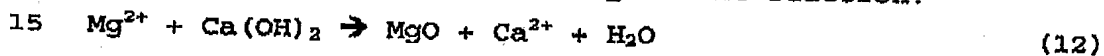


5 Precious metal extraction where required is via NaSH addition and is followed by precipitation of the remaining base metal ions with slaked lime addition according to the reaction:



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In the nickel and cobalt precipitation step nickel and cobalt are precipitated by slaked lime addition. In the final precipitation step magnesium is precipitated by slaked lime addition according to the reaction:



The  $\text{CaCl}_2$  rich liquor remaining is returned to the leach as the first washing step for the leach residue.

Whilst the invention has been described with reference to a preferred embodiment, it will be appreciated that it can be embodied in many other forms.

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The Claims defining the Invention are as follows:

1. A process for recovering a target metal from a laterite ore comprising the steps of:
  - in a leaching stage, leaching the laterite ore (or a concentrate thereof) with an acidic aqueous halide solution to leach the target metal into solution, the leaching solution being generated by adding sulfuric acid to a solution comprising a metal halide;
  - passing the solution from the leaching stage to a precipitation stage in which a precipitate of the target metal is formed by adding a precipitation agent to the solution; and
  - separating the solution from the target metal precipitate and returning the solution with the metal halide therein to the leaching stage.
2. A process as claimed in claim 1 wherein a solution metal is selected that forms a precipitate with the sulfate anion of the acid, such that a hydrohalous acid forms as the metal sulfate precipitates.
3. A process as claimed in claim 2 wherein the solution metal is calcium so that the precipitate is calcium sulfate.
4. A process as claimed in any one of the preceding claims wherein the halide is chloride.
5. A process as claimed in any one of the preceding claims wherein the laterite ore includes precious metals and the halide is chloride and bromide.
6. A process as claimed in any one of the preceding claims wherein addition of the precipitation agent introduces the solution metal.
7. A process as claimed in any one of the preceding claims wherein the leaching stage comprises first and second leaching stages operating in a counter-current

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configuration, and wherein the sulfuric acid is added to the second stage.

8. A process as claimed in claim 7 wherein the laterite ore or concentrate is fed to the first leaching stage and is contacted with a recycle of residual acid in solution from the second leaching stage to leach the ore or concentrate and produce at least partially leached laterite solids in the solution, and wherein the solution is separated from the solids and is passed to the precipitation stage, and the solids are passed to the second leaching stage for contact with the added sulfuric acid to further leach the laterite solids.

9. A process as claimed in claim 8 wherein the laterite ore or concentrate includes iron such that a proportion of iron is leached into solution in the first leaching stage and a proportion of leached iron is precipitated as ferric oxide, the ferric oxide precipitate passing with the solids to the second leaching stage.

10. A process as claimed in claim 9 wherein air is added to the first and/or second leaching stages, optionally with the addition of copper as the CuI/CuII couple, to enhance iron precipitation as ferric oxide.

11. A process as claimed in any one of claims 8 to 10 wherein the leached solids and solution from the second leaching stage are separated in a separation stage, with the solution being recycled to the first leaching stage and the solids discarded.

12. A process as claimed in claim 11 wherein the return solution from the precipitation stage is first passed to the separation stage to wash the separated solids, prior to being recombined with the solution recycled to the first leaching stage.

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13. A process as claimed in any one of the preceding claims wherein the precipitation stage comprises an iron removal stage and one or more subsequent target metal precipitation stage(s).
- 5 14. A process as claimed in claim 13 wherein, in the iron removal stage, iron in solution is caused to precipitate by adding to the solution a carbonate of the solution metal, and the precipitate is then separated from the solution.
- 10 15. A process as claimed in claim 14 wherein, when the solution metal is calcium, the carbonate is calcium carbonate, the addition to the solution of which increases solution pH and causes iron to precipitate as ferric oxide.
- 15 16. A process as claimed in any one of claims 13 to 15 wherein, when the target metal includes a precious metal, the precious metal is removed as a precipitate by adding NaSH to the solution.
- 20 17. A process as claimed in any one of claims 13 to 16 wherein, when the target metal is nickel and/or cobalt, the nickel and/or cobalt is removed as a precipitate by adding to the solution a hydroxide of the solution metal.
18. A process as claimed in claim 17 wherein, when the solution metal is calcium, the hydroxide is calcium
- 25 hydroxide.
19. A process as claimed in claim 18 wherein the calcium hydroxide is slaked lime.
20. A process as claimed in any one of the preceding claims wherein the ore or concentrate has a residence time
- 30 in the leaching stage such that iron present in the laterite is leached and oxidised through to haematite.
21. A process as claimed in claim 20 wherein the residence time is greater than 10 hours.

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22. A process as claimed in any one of the preceding claims wherein the sulfuric acid is added to the leaching stage to achieve a pH in the range 0 to 1 and a solution Eh of -600mV.
- 5 23. A process as claimed in any one of the preceding claims wherein the temperature of the solution in the leaching stage is in the range 85 - 95°C.
24. A process as claimed in any one of the preceding claims wherein, when the halide is chloride, total  
10 chloride concentration is in the range of 6 to 8 M.
25. A process as claimed in any one of the preceding claims wherein, when the halide is chloride and the solution metal is calcium, at least 30g/l of CaCl<sub>2</sub> is maintained in the leaching stage.
- 15 26. A process as claimed in any one of the preceding claims wherein the target metal includes nickel and/or cobalt.
27. A process for leaching a target metal from a laterite ore (or a concentrate thereof), the process comprising  
20 first and second leaching stages having an acidic aqueous halide solution for leaching the target metal into solution passing counter-currently therethrough, wherein acid is added to the second stage, and the laterite ore or concentrate is fed to the first leaching stage and  
25 contacted with a recycle of residual acid in solution from the second leaching stage to leach the ore or concentrate and produce at least partially leached laterite solids in the solution, and wherein the solution is separated from the solids and may be passed to target metal recovery, and  
30 the solids are passed to the second leaching stage for contact with the added acid to further leach the laterite solids.

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28. A process as claimed in claim 27 wherein the laterite ore or concentrate includes iron such that a proportion of iron is leached into solution in the first leaching stage and a proportion of leached iron is precipitated as ferric oxide, the ferric oxide precipitate passing with the solids to the second leaching stage.

29. A process for recovering a target metal from a laterite ore comprising the steps of:

- in a leaching stage, leaching the laterite ore (or a concentrate thereof) with an acidic aqueous halide solution to leach the target metal into solution, the leaching solution being generated by adding sulfuric acid to a solution comprising a metal halide; and
- passing the solution from the leaching stage to a purification stage in which the target metal is separated from the solution and the solution with the metal halide therein is returned to the leaching stage.

30. A process as claimed in any one of claims 27 to 29 which is otherwise as defined in any one of claims 1 to 26.

31. A process for recovering a target metal from a laterite ore substantially as herein described with reference to the accompanying drawing and/or the example.

32. Any metal produced by the process of any one of the preceding claims.

Dated this 25th day of March 2004

Intec Ltd

By its Patent Attorneys

GRIFFITH HACK

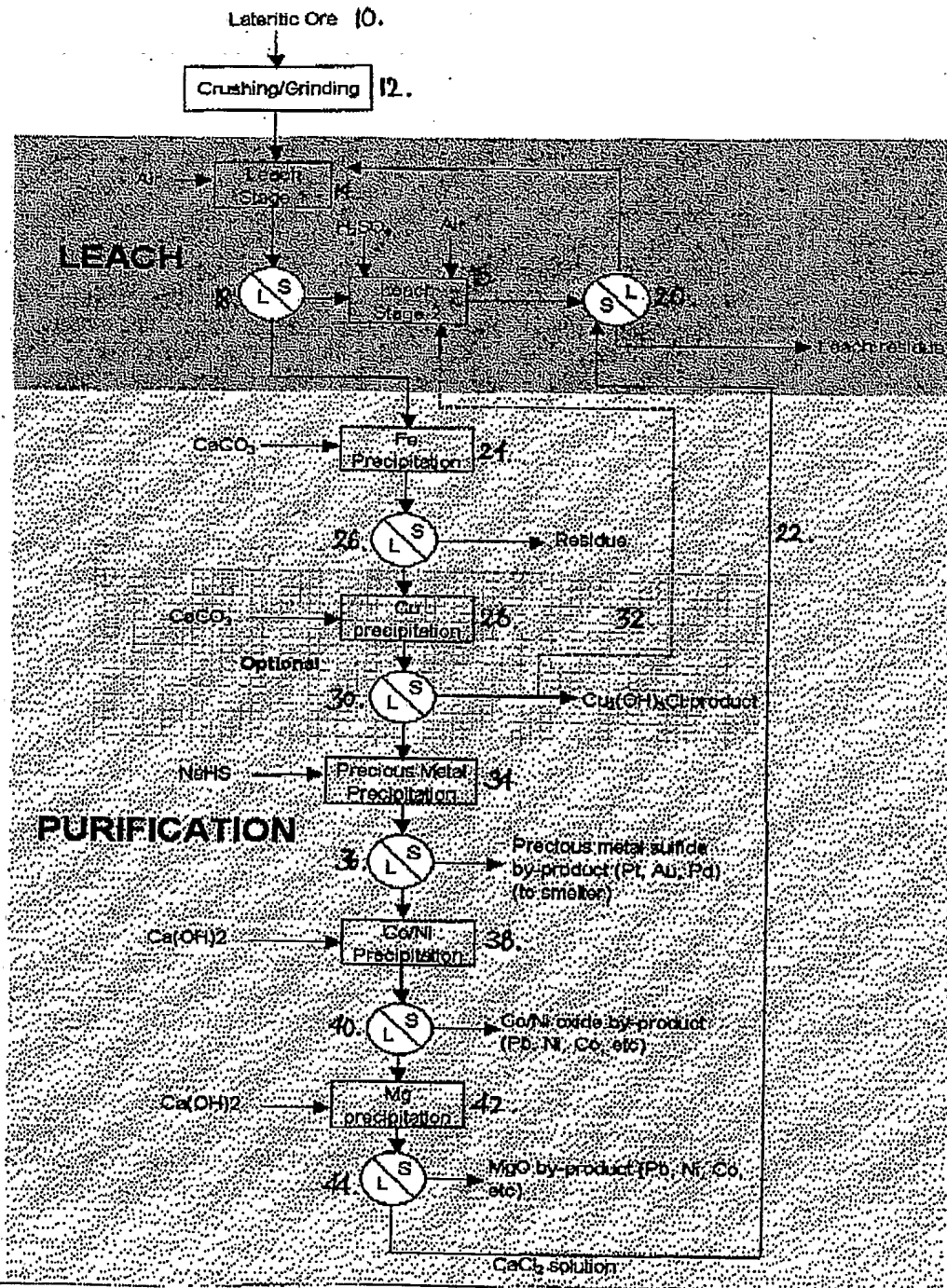


FIG. 1